MOTOROLA

SMR
6901

Manual Revision

QUANTAR™ Instruction Manuals

This SMR applies to two instruction manuals listed below. The changes described in this SMR will be included in the next update of the manuals. This revision contains information on new control modules released since the manuals were last printed.

68P81095E05-D
Quantar ™ Digital-Capable Station for Conventional, *SECURENET*, ASTRO®, 6809 Trunking, and *IntelliRepeater* Systems

Station control modules CLN6960 and CLN1614 have been replaced by new model CLN8426A. Station control module CLN6961 has been replaced by new model CLN8447A. The new modules are functionally identical to the assemblies they replace.

If you have this manual, please make the following changes:

Table of Contents:

- Replace with the updated Table of Contents section included in this SMR (section **68P81095E05D**, dated 12/01/2007)

DESCRIPTION Tab:

- Replace pages 9, 10, and 11 in Section 68P81096E56-B with the new pages 9, 10, and 11 included with this SMR.

MAINTENANCE AND TROUBLESHOOTING Tab:

- Replace pages 27–32 in Section 68P81096E59-C with the new pages 27–32 included with this SMR.

STATION CONTROL CIRCUITRY Tab:

- Replace section 68P81094E76-C behind the “Station Control Circuitry” tab in your manual with the attached new section 68P81094E76-D.
- Remove and discard the section 68P81096E87-A for the CLN1614 SCM; this module is no longer available.

68P81094E85-O
ASTRO-TAC™ Receiver For Analog/ASTRO® and Analog/ SECURENET Systems

Station control modules TTN4094A/B and TRN7900A/B have been replaced by new models CLN8426A and CLN8447A. The new modules are functionally identical to the assemblies they replace.

If you have this manual, please make the following changes:

DESCRIPTION Tab:

- The following paragraph replaces the “Introduction” paragraph on page 6:

  The Station Control Module (SCM) is the microprocessor – based controller for the station. Major components include an MC68360 microprocessor, a 56311 Digital Signal Processor (DSP), and two programmable devices, a CPLD for the host and a FPGA for the DSP. The SCM operates as follows:

- Replace all occurrences of “DSP ASIC” with “DSP FPGA”. The SCM now uses a field-programmable gate array (FPGA) instead of an application-specific IC (ASIC).

STATION CONTROL CIRCUITRY Tab:

- Replace section **68P81090E94-O** behind the “Station Control Circuitry” tab in your manual with the attached new section **68P81094E76-D**.

The remaining pages of this SMR are not needed for 68P81094E85-O and may be discarded.

QUANTAR®

Digital - Capable Station

For Conventional, SECURENET, ASTRO,
6809 Trunking, and *Intellirepeater* Systems

VHF - 25W & 125W
UHF - 25W, 100W & 110W
800 MHz - 20W &100W
900 MHz - 100W

Instruction Manual

68P81095E05-D

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QUANTAR®
Digital–Capable Station

for Conventional, ASTRO, 6809 Trunking, and IntelliRepeater Systems

VHF — 25W & 125W
UHF — 25W, 100W, & 110W
800 MHz — 20W & 100W
900 MHz — 100W

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Networks & Enterprise
1301 E. Algonquin Schaumburg, IL 60196

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FOREWORD

Product Maintenance Philosophy

Due to the high percentage of surface-mount components and multi-layer circuit boards, the maintenance philosophy for this product is one of Field Replaceable Unit (FRU) substitution. The station is comprised of self-contained modules (FRUs) which, when determined to be faulty, may be quickly and easily replaced with a known good module to bring the equipment back to normal operation. The faulty module must then be shipped to the Motorola System Support Center for further troubleshooting and repair to the component level.

Scope of Manual

This manual is intended for use by experienced technicians familiar with similar types of equipment. In keeping with the maintenance philosophy of Field Replaceable Units (FRU), this manual contains functional information sufficient to give service personnel an operational understanding of all FRU modules, allowing faulty FRU modules to be identified and replaced with known good FRU replacements.

The information in this manual is current as of the printing date. Changes which occur after the printing date are incorporated by Instruction Manual Revisions (SMR). These SMRs are added to the manuals as the engineering changes are incorporated into the equipment.

Service and Replacement Modules

For complete information on ordering FRU replacement modules, or instructions on how to return faulty modules for repair, contact the System Support Center:

Motorola System Suppor1 Center
2214 Galvin Drive
Elgin, IL 60123
1-800-221-7144
Int'l 1-847-576-7300
FAX 1-847-576-2172

The following FRU replacement modules are available:

Receiver Module (VHF Range 1)	TLN3250
Receiver Module (VHF Range 2)	TLN3251
Receiver Module (UHF Range 0)	DLN1215
Receiver Module (UHF Range 1)	TLN3313
Receiver Module (UHF Range 2)	TLN3314
Receiver Module (UHF Range 3)	TLN3373
Receiver Module (UHF Range 4)	TLN3374
Receiver Module (800 MHz)	TLN3315
Receiver Module (900 MHz)	TLN3316
Exciter Module (VHF Range 1)	TLN3252
Exciter Module (VHF Range 2)	TLN3253
Exciter Module (UHF Range 0)	DLN1214
Exciter Module (UHF Range 1)	TLN3305
Exciter Module (UHF Range 2)	TLN3306
Exciter Module (UHF Range 3)	TLN3375
Exciter Module (UHF Range 4)	TLN3376
Exciter Module (800 MHz)	TLN3307
Exciter Module (900 MHz)	TLN3308
Power Amplifier Module (VHF 25W, R1 & R2)	TLN3255
Power Amplifier Module (VHF 125W, R1)	TLN3379
Power Amplifier Module (VHF 125W, R2)	TLN3254
Power Amplifier Module (UHF Range 0; 110W)	DLN1216
Power Amplifier Module (UHF Range 1; 25W)	TLN3443
Power Amplifier Module (UHF Range 2; 110W)	TLN3446
Power Amplifier Module (UHF Range 4; 100W)	TLN3450
Power Amplifier Module (800 MHz 20W)	TLN3441
Power Amplifier Module (800 MHz 100W)	TLN3442
Power Amplifier Module (900 MHz 100W)	TLN3299
Station Control Module (Conventional/6809/EPIC V)	CLN8426
Station Control Module (EPIC IV)	CLN7692
Station Control Module (*IntelliRepeater* EPIC V)	CLN8447
4–Wire Wireline Interface Module	CLN1295
8–Wire Wireline Interface Module	CLN1296
Power Supply Module (625W AC)	TLN3259
Power Supply Module (625W AC w/charger)	TLN3260
Power Supply Module (265W AC)	TLN3261
Power Supply Module (265W AC w/charger)	TLN3262
Power Supply Module (210W 12/24 V DC)	TLN3264
Power Supply Module (210W 48/60 V DC)	TLN3378
Power Supply Module (600W 24 V DC)	TLN3263
Power Supply Module (600W 48/60 V DC)	TLN3377
ASTRO Modem Card	TLN3265

GENERAL SAFETY INFORMATION

The following general safety precautions must be observed during all phases of operation, service, and repair of the equipment described in this manual. The safety precautions listed below represent warnings of certain dangers of which we are aware. You should follow these warnings and all other safety precautions necessary for the safe operation of the equipment in your operating environment.

General Safety Precautions

- Read and follow all warning notices and instructions marked on the product or included in this manual before installing, servicing or operating the equipment. Retain these safety instructions for future reference. Also, all applicable safety procedures, such as Occupational, Safety, and Health Administration (OSHA) requirements, National Electrical Code (NEC) requirements, local code requirements, safe working practices, and good judgement must be used by personnel.
- Refer to appropriate section of the product service manual for additional pertinent safety information.
- Because of danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modifications of equipment.
- Identify maintenance actions that require two people to perform the repair. Two people are required when:
    - A repair has the risk of injury that would require one person to perform first aid or call for emergency support. An example would be work around high voltage sources. A second person may be required to remove power and call for emergency aid if an accident occurs to the first person. **Note** *Use the National Institute of Occupational Safety and Health (NIOSH) lifting equation to determine whether a one or two person lift is required when a system component must be removed and replaced in its rack.*
- If troubleshooting the equipment while power is applied, be aware of the live circuits.
- DO NOT operate the transmitter of any radio unless all RF connectors are secure and all connectors are properly terminated.
- All equipment must be properly grounded in accordance with *Motorola Standards and Guideline for Communications Sites* 68P81089E50 (sometimes referred to as “R56 Manual”) and specified installation instructions for safe operation.
- Slots and openings in the cabinet are provided for ventilation. To ensure reliable operation of the product and to protect if from overheating, these slots and openings must not be blocked or covered.
- Only a qualified technician familiar with similar electronic equipment should service equipment.
- Some equipment components can become extremely hot during operation. Turn off all power to the equipment and wait until sufficiently cool before touching.
- Never store combustible materials in or near equipment racks. The combination of combustible material, heat, and electrical energy increases the risk of a fire safety hazard.

Human Exposure Compliance

This equipment is designed to generate and radiate radio frequency (RF) energy by means of an external antenna. When terminated into a non-radiating RF load, the base station equipment is certified to comply with Federal Communications Commission (FCC) regulations pertaining to human exposure to RF radiation In accordance with the FCC Rules Part 1 section 1.1310 as published in title 47 code of federal regulations and procedures established in TIA/EIA TSB92, Report On EME Evaluation for RF Cabinet Emissions Under FCC MPE Guidelines. Compliance to FCC regulations of the final installation should be assessed and take into account site specific characteristics such as type and location of antennas, as well as site accessibility of occupational personnel (controlled environment) and the general public (uncontrolled environment). This equipment should only be installed and maintained by trained technicians. Licensees of the FCC using this equipment are responsible for insuring that its installation and operation comply with FCC regulations Part 1 section 1.1310 as published in title 47 code of federal regulations.

Whether a given installation meets FCC limits for human exposure to radio frequency radiation may depend not only on this equipment but also on whether the “environments” being assessed are being affected by radio frequency fields from other equipment, the effects of which may add to the level of exposure. Accordingly, the overall exposure may be affected by radio frequency generating facilities that exist at the time the licensee's equipment is being installed or even by equipment installed later. Therefore, the effects of any such facilities must be considered in site selection and in determining whether a particular installation meets the FCC requirements.

FCC OET Bulletin 65 provides materials to assist in making determinations if a given facility is compliant with the human exposure to RF radiation limits. Determining the compliance of transmitter sites of various complexities may be accomplished by means of computational methods. For more complex sites direct measurement of the power density may be more expedient. Additional information on the topic of electromagnetic exposure is contained in the *Motorola Standards and Guideline for Communications Sites* publication. Persons responsible for installation of this equipment are urged to consult the listed reference material to assist in determining whether a given installation complies with the applicable limits.

In general the following guidelines should be observed when working in or around radio transmitter sites: ~ All personnel should have electromagnetic energy awareness training

- All personnel entering the site must be authorized ~ Obey all posted signs
- Assume all antennas are active
- Before working on antennas, notify owners and disable appropriate transmitters
- Maintain minimum 3 feet clearance from all antennas ~ Do not stop in front of antennas
- Use personal RF monitors while working near antennas
- Never operate transmitters without shields during normal operation ~ Do not operate base station antennas in equipment rooms

For installations outside of the U.S., consult with the applicable governing body and standards for RF energy human exposure requirements and take the necessary steps for compliance with local regulations.

References

- TIA/EIA TSB92 “Report On EME Evaluation for RF Cabinet Emissions Under FCC MPE Guidelines,” Global Engineering Documents: http://global.ihs.com/
- FCC OET Bulletin 65 “Evaluating Compliance with FCC Guidelines for Human Exposure to Radio frequency Electromagnetic Fields”: http://www.fcc.gov/oet/rfsafety/
- *Motorola Standards and Guideline for Communications Sites*, Motorola manual 68P81089E50
- IEEE Recommended Practice for the Measure of Potentially Hazardous Electromagnetic Fields – RF and Microwave, IEEE Std C95.3–1991, Publication Sales, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331
- IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz, IEEE C95.1–1991, Publication Sales, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331

Receiver Circuitry Operation

Introduction

The Receiver Circuitry accepts rf signals from the site receive antenna, performs filtering and dual conversion, and outputs a digitized receive signal to the Station Control Module.

Receiver Module Operation

The receive signal is input from the site receive antenna to a multi-pole preselector filter which provides highly selective bandpass filtering. The filtered signal is then amplified and fed to the rf input of the 1st mixer, which mixes the signal with an injection signal generated by the synthesizer/VCO, resulting in a 21.45 MHz (VHF) or a 73.35 MHz (UHF, 800, 900) 1st i–f (intermediate frequency) signal. (The injection signal frequency is determined by frequency programming data from the Station Control Module via the SPI bus.)

The 21.45 MHz or 73.35 MHz 1st i–f signal is filtered and input to a custom receiver IC. This component contains circuitry for 2nd injection and mixing, amplification, and A/D (analog to digital) conversion, resulting in a digitized receive signal. This signal is fed as differential data to the Station Control Module.

Station Control Module Operation

Introduction

The Station Control Module (SCM) is the microprocessor – based controller for the station. Major components include an MC68360 microprocessor, a 56311 Digital Signal Processor (DSP), and two programmable devices, a CPLD for the host and a FPGA for the DSP. The SCM operates as follows:

Station Control Module Operation

The Host Microprocessor (μP) serves as the controller for the SCM, operating from the station software stored in FLASH memory. This software determines the system capabilities of the station (analog, ASTRO, etc.) The Host μP communicates with the station modules and the SCM circuitry via address and data buses, an HDLC bus, and a SPI bus. External communications ports include a serial port SCM (front panel and backplane) and an Ethernet port (backplane).

The DSP and DSP FPGA perform the necessary digital processing for the station audio and data signals. The DSP circuitry interfaces with the Receiver Module (receive audio), the Exciter Module (modulation signals), the Wireline Interface Board (wireline audio), and external audio devices (microphone, handset, external speaker, and station local speaker).

The 2.1 MHz Reference Oscillator generates the reference signal used by the Receiver and Exciter Modules.

Wireline Interface Board Operation

Introduction

The Wireline Interface Board (WIB) serves as the interface between the customer telephone lines and the station. In general, the WIB processes and routes all wireline audio signals between the station and the landline equipment (such as consoles, modems, etc.). Landline-to-station and station-to-landline audio signals are connected to the WIB via copper pairs at the rear of the station.

Wireline Interface Board Operation

Note: *The WIB is offered in 4−wire and 8−wire models. The WIB shown in the block diagram is a simplified 4−wire model. Refer to the functional sections located behind tab WIRELINE CIRCUITRY for details on both models.*

The WIB contains a microprocessor, two FLASH memory ICs (which contain the WIB operating software downloaded by the SCM), and an ASIC device to process and route the various audio signals. Analog and *ASTRO* signals are processed as follows.

- Analog signals are converted to digital signals and routed to the SCM via the TDM (time division multiplex) bus.
- *ASTRO* and *ASTRO CAI* data signals are processed by an *ASTRO* modem card (daughter board plugged into the WIB) and sent to/from the SCM via the HDLC bus. (The station operates in *transparent* mode only, and **does not** perform encryption or decryption of the *ASTRO* or *ASTRO CAI* signal.)

The WIB also contains the I/O circuitry used with the WildCard Option. Refer to the *Quantar*/*Quantro* RSS User's Guide (68P81085E35) for more information on the WildCard Option.

Power Supply Module Operation

The Power Supply Module is a switching−type power supply which accepts an ac input (90−280 V ac, 47−63 Hz) and generates the necessary dc operating voltages for the station modules. Stations rated at 20/25 W output power are equipped with Power Supply Modules which generate +5 and +14.2 V dc. Stations rated at 100/110/125 W output power are equipped with Power Supply Modules which generate +5, +14.2 V, and +28 V dc.

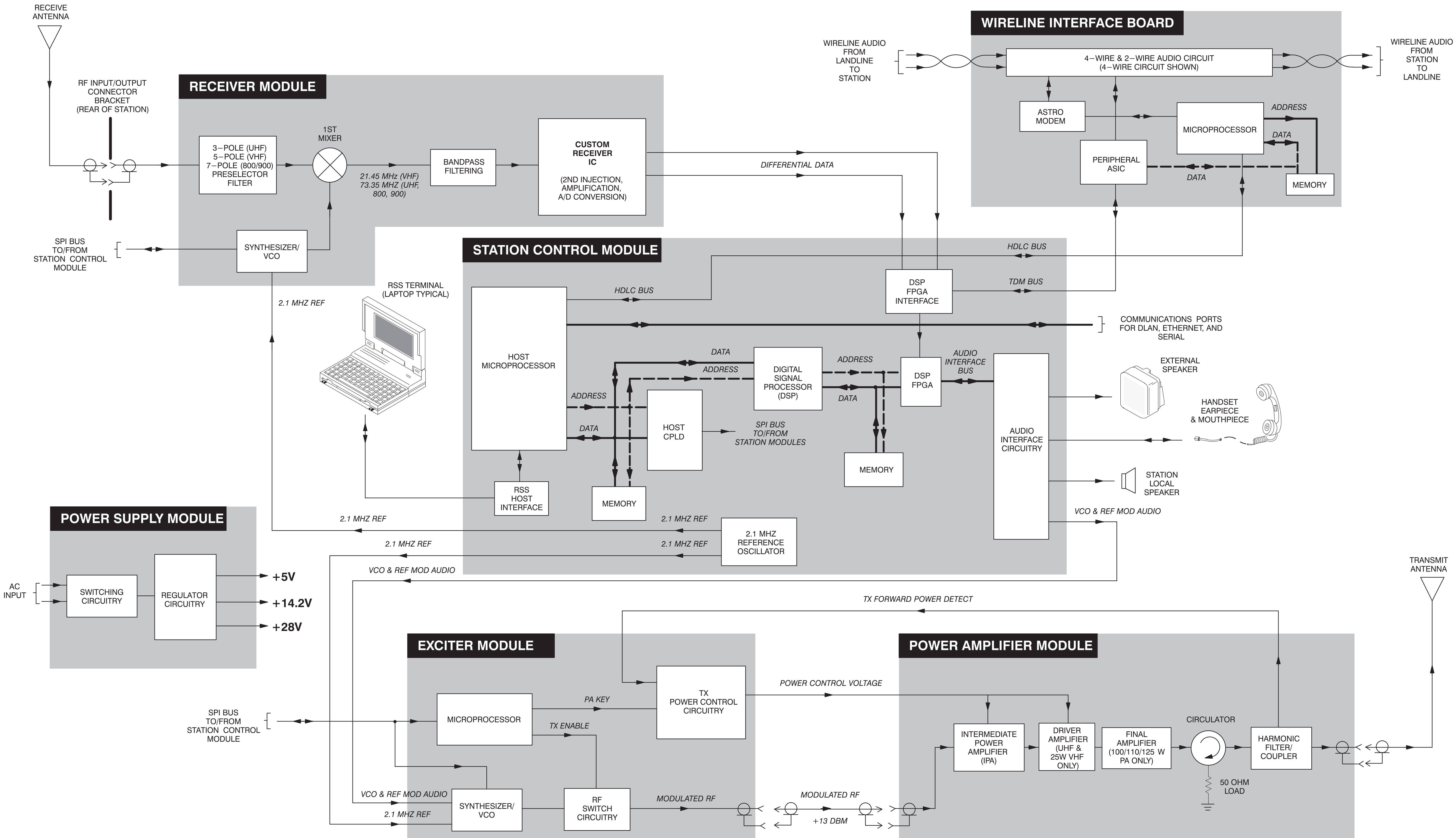
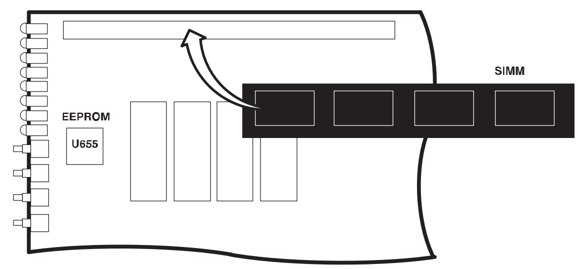


Figure 3. *Quantar* Station Functional Block Diagram

Replacing Station Control Module (Conventional/6809) (Continued)

Replacement Procedure (continued)

Software on Single FLASH SIMM



Note: *When inserting Station Control Board into cage, place your thumbs on the BNC and D-type connectors and firmly push the board into the backplane connector.*

Step 5. Install replacement Station Control Board by sliding board into cage and firmly seating the board card-edge connectors into the backplane. (**Do not** slam the board against the backplane or push any harder than necessary to seat the connectors.)

Step 6. Replace the front panel by pressing it into place and replacing the two screws. Be sure the 2-wire cable from the local speaker is connected to the 3-pin connector at the bottom front of the Station Control Board. If the connector is not keyed (earlier models), you may connect the 3-pin connector in either polarity.

Step 7. Restore power to the station.

Post-Replacement Optimization Procedure

Alignment Procedures
- RX Wireline
- TX Wireline
- Squelch Adjust
- Battery Equalization (if required)
- Power Output
- Tx Deviation Gain Adjust
- Reference Modulation

For *ASTRO* stations, also perform RSSI and Simulcast/ASTRO Launch Time Offset alignment.

For 6809 Trunking stations, also perform TDATA alignment.

Step 1. Replacement Station Control Modules are shipped with default data programmed into the codeplug (EEPROM located on board). After replacing a Station Control Board, you must download codeplug data (unique to the particular station) to the replacement board codeplug. Simply retrieve the file from your archive and follow the instructions in the RSS User's Guide (68P81085E35) for saving data to the codeplug. Note that if no archive codeplug file exists, you may create a new codeplug by copying the ***training.cp*** codeplug file (supplied with the RSS) and then program it as necessary to meet the particular station's requirements.

Step 2. Calibrate the reference oscillator (station reference) by performing the procedure in the Routine Maintenance section of this manual.

Step 3. Perform the alignment procedures listed in the sidebar as described in the RSS User's Guide (68P81085E35).

Replacing Station Control Module (for modules in *IntelliRepeater* Ethernet Networks)

Replacement Procedure

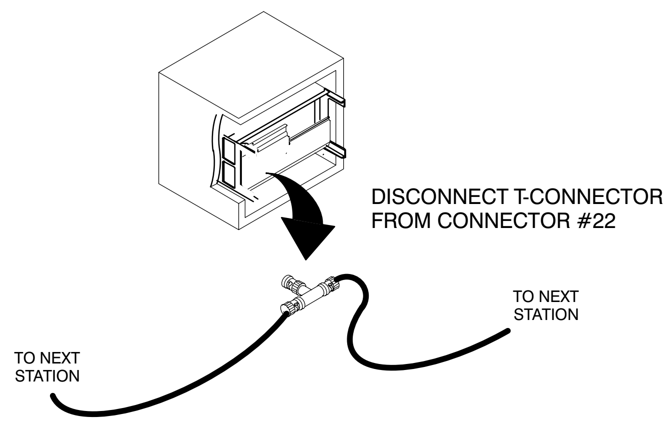
Step 1. If the module is capable of communicating with the RSS, connect the PC to the RSS port, start the RSS program, and save the codeplug from the station to a file on the PC hard disk. This will allow the codeplug information to be downloaded to the codeplug located on the replacement Station Control Board. If the module cannot communicate with the RSS, an archive file (if available) of the particular station codeplug may be downloaded. If no archive codeplug file exists, you must program the codeplug as described in the RSS User's Guide (68P81085E35).

Note *If the Physical Address and/or the IP Address cannot be read, contact the System Support Center at 1-800-221-7144.*

Step 2. Using the RSS, read the *IP Address* and *Physical Address* assigned to the station and jot them down. (From the RSS **Main Menu**, go to **Service:Ethernet Parameters** to read the *IP Address* and the *Physical Address*.)

Step 3. Turn off station power (refer to page 22).

Step 4. Disconnect the station from the Ethernet LAN as described below.



Step 5. Using a Torx #15 driver, remove front panel and Station Control Board as described in Figure 6.

Note *Use an IC Extraction Tool (Motorola Part No. 01–80386A04) to remove the firmware devices.*

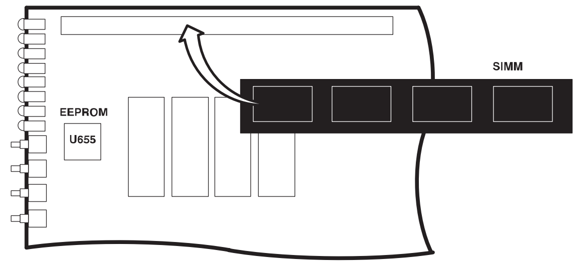
Step 6. The Station Control Board software must now be removed from the old board and installed onto the replacement board. The software is contained on a single FLASH SIMM. You must remove the FLASH SIMM from the replacement board and install the FLASH SIMM from the old board. The following illustration shows the location of the FLASH SIMM.

Replacing Station Control Module (for modules in *IntelliRepeater* Ethernet Networks) (Continued)

Replacement Procedure (continued)

Note *If the existing FLASH SIMM is faulty, contact the System Support Center at 1-800-221-7144 to obtain a replacement part.*

Software on Single FLASH SIMM



Note *The replacement board must have the same model number as the faulty board (e.g., CLN6960). If it does not, contact the System Support Center at 1-800-221-7144 for instructions on how to proceed.*

Note: *When inserting Station Control Board into cage, place your thumbs on the BNC and D−type connectors and firmly push the board into the backplane connector.*

Step 7. Install replacement Station Control Board by sliding board into cage and firmly seating the board card-edge connectors into the backplane. (**Do not** slam the board against the backplane or push any harder than necessary to seat the connectors.)

Step 8. Replace the front panel by pressing it into place and replacing the two screws. Be sure the 2-wire cable from the local speaker is connected to the 3-pin connector at the bottom front of the Station Control Board. If the connector is not keyed (earlier models), you may connect the 3-pin connector in either polarity.

Step 9. Restore power to the station.

Post-Replacement Optimization Procedure

Step 1. Replacement Station Control Modules are shipped with default data programmed into the codeplug (EEPROM located on board). After replacing a Station Control Board, you must download codeplug data (unique to the particular station) to the replacement board codeplug. Simply retrieve the file from your archive and follow the instructions in the RSS User's Guide (68P81085E35) for saving data to the codeplug. Note that if no archive codeplug file exists, you may copy a codeplug from another station at the site and save it to this station.
Important! When the RSS prompts you to "Crossload" the other stations at the site, answer **NO**.

Step 2. Using the RSS, navigate to **Service:Ethernet Parameters** and change the *IP Address* and *Physical Address* to the addresses you read in Step 2 on page 28.

Step 3. Calibrate the reference oscillator (station reference) by performing the procedure in the Routine Maintenance section of this manual.

Step 4. Perform the alignment procedures listed in the sidebar as described in the RSS User's Guide (68P81085E35).

Alignment Procedures
- RX Wireline
- TX Wireline
- Squelch Adjust
- Battery Equalization (if required)
- Power Output
- Tx Deviation Gain Adjust
- Reference Modulation

For *ASTRO* stations, also perform RSSI and Simulcast/ASTRO Launch Time Offset alignment.

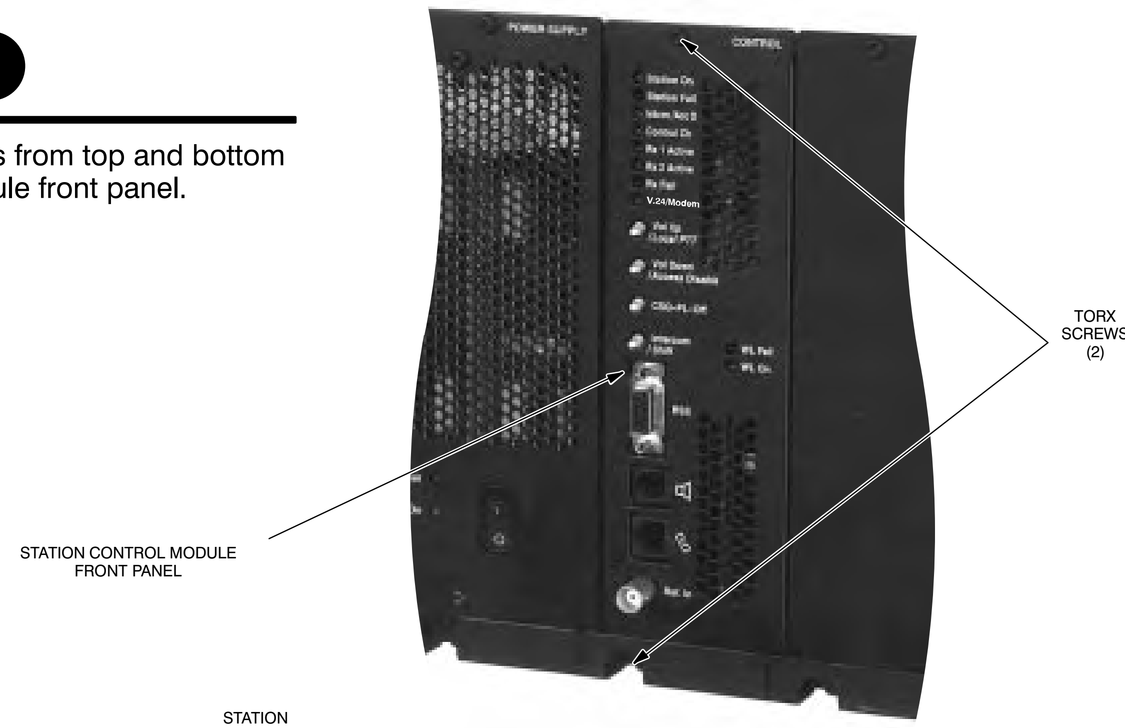
Step 5. Turn off station power (refer to page 22).

Step 6. Reconnect the T-connector from the Ethernet LAN.

Step 7. Restore power to the station.

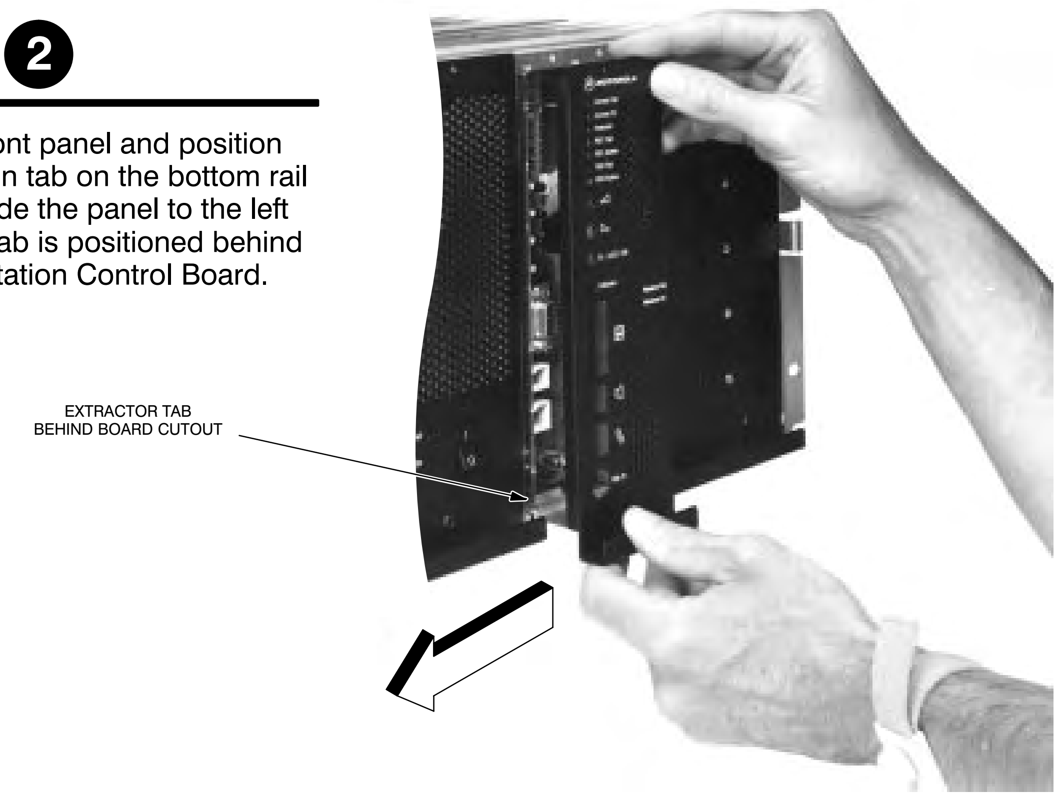
1

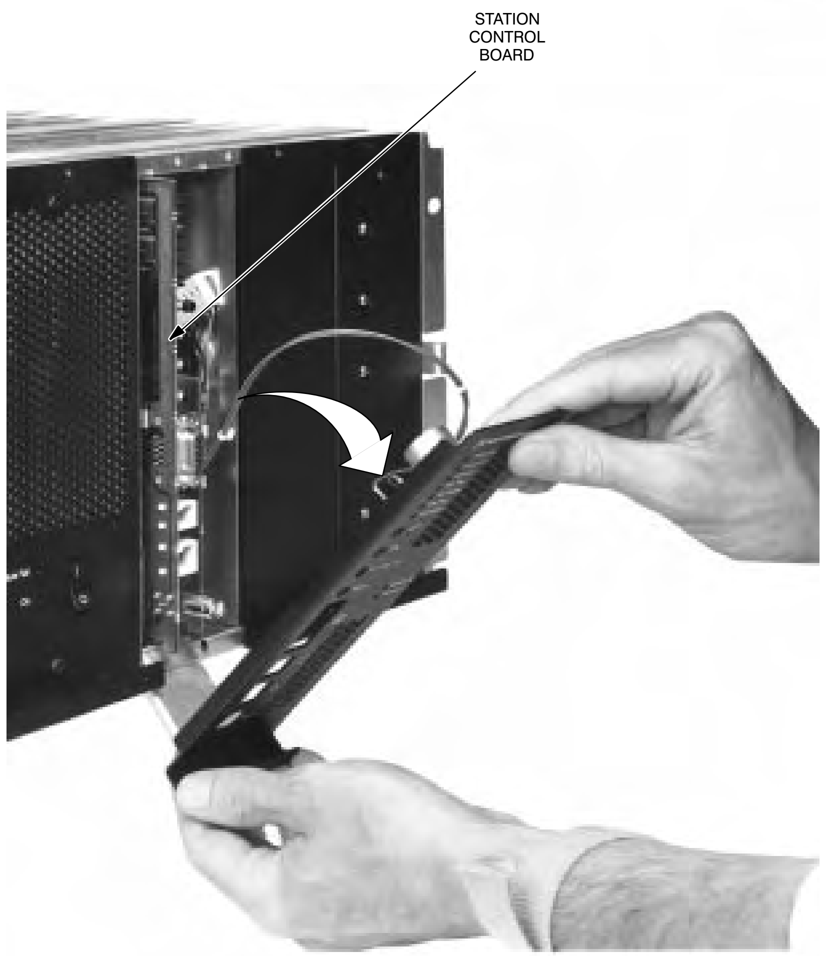
Remove the two screws from top and bottom of Station Control Module front panel.



2

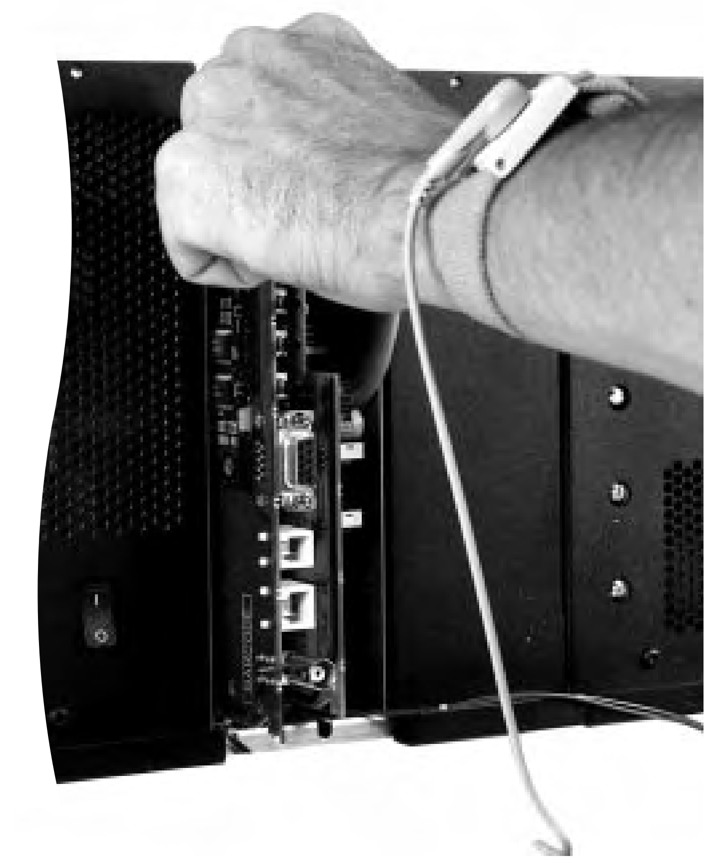
Partially remove front panel and position the board extraction tab on the bottom rail of the cage and slide the panel to the left until the lip of the tab is positioned behind the cutout in the Station Control Board.





3

Tip back on the panel to pry the Station Control Board out of the backplane connectors.



4

Remove Station Control Board from cage.

Figure 6. Removal Procedure for Station Control Board (*Quantar* VHF Station Shown)

Replacing Wireline Interface Board

Note *A later model board (CLNxxxx) can be used to replace both later model boards and earlier model boards (TRNxxxx). However, earlier model boards cannot be used to replace later model boards. (Later model boards support either EPROMs or FLASH; earlier model boards support only EPROMs.)*

Replacement Procedure

Step 1. Turn off station power (refer to page 22).

Step 2. Using a Torx #15 driver, remove anti-vibration screw(s) (if installed) from top and/or bottom of module front panel.

Step 3. Remove Station Control Module front panel and Wireline Interface Board as described in Figure 6.

Step 4. Set all jumpers on replacement board to match those on the faulty board. These include input/output impedance matching jumpers, 2-wire/4-wire select jumper, and dc remote control selection jumpers.

Step 6. Install replacement Wireline Interface Board by sliding board into cage and firmly seating the board card-edge connectors into the backplane. (**Do not** slam the board against the backplane or push any harder than necessary to seat the connectors.)

Step 7. Replace the front panel by pressing it into place and replacing the two screws. Be sure the 2-wire cable from the local speaker is connected to the 3-pin connector at the bottom front of the Station Control Board. If the connector is not keyed (earlier models), you may connect the 3-pin connector in either polarity.

Step 8. Restore power to the station.

Post-Replacement Optimization Procedure

Perform the *Rx Wireline* and *Tx Wireline* adjustment procedures located in the RSS User's Guide (68P81085E35).

MOTOROLA

STATION CONTROL MODULE

MODELS CLN8426A
CLN8447A

1 DESCRIPTION

The Models CLN8426A and CLN8447A station control modules (SCM) are described in this section. A general description, identification of controls, indicators, and inputs/outputs, a functional block diagram, and functional theory of operation are provided. The information provided is sufficient to give service personnel a functional understanding of the module, allowing maintenance and troubleshooting to the module level. (Refer also to the *Maintenance and Troubleshooting* section of this manual for detailed troubleshooting procedures for all modules in the station.)

General Description

The SCM serves as the main controller for the station. The SCM board contains a 68EN360 microprocessor, a 56311 digital signal processor (DSP), and support circuitry that combine to provide signal processing and operational control over the other station modules. The SCM also contains the station operating software (stored in FLASH memory) and codeplug which define the personality of the station, including system capabilities (ASTRO, IntelliRepeater, etc.) and operating parameters such as output power and operating frequency.

The CLN8426A provides conventional operation along with MRTI and 6809 trunking capabilities. The CLN8447A is a full-featured model required for use in IntelliRepeater applications. Specific differences between the models are shown throughout the functional block diagram (Figure 2).

Overview of Circuitry

The SCM contains the following circuitry:

- **Host Microprocessor** (µP)— The 68EN360 µP is the central controller of the SCM and station
- **Non-Volatile Memory** — consists of a FLASH SIMM module that contains the station operating software and data, and an EEPROM that contains the station codeplug data
- **SDRAM Memory** — Synchronous RAM into which station software is downloaded and executed

- **External Line Interface Circuitry** — provides interface between the SCM and external devices such as IntelliRepeater DLAN ports, RSS port, an Ethernet port, and miscellaneous backplane connectors
- **Digital Signal Processor (DSP) and DSP FPGA Circuitry** — performs high-speed processing of audio and signaling data signals
- **Station Reference Circuitry** — generates the 2.1 MHz reference signal used throughout the station
- **HDLC Bus Control Circuitry** — provides bus control to allow host communications port SCC3 to communicate with the wireline interface board (WIB) and other optional modules via the HDLC interprocessor communications bus
- **Audio Interface Circuitry** — routes the various audio input signals (such as microphone, wireline, and receiver audio) to output devices (such as external speaker, built-in local speaker, and exciter modulation inputs)
- **Input/Output Ports Circuitry** — two 32-line output buses allow miscellaneous control signals to be sent to various circuits throughout the station; two 32-line input buses allow miscellaneous inputs to be received from throughout the station
- **Front Panel LEDs and Switches** — general purpose input/output ports control eight status LEDs and accept inputs from four momentary switches, all located on the SCM front panel
- **Supply Voltage Circuitry** — contains filtering and regulator circuitry which accepts +14.2 V and +5 V from backplane and generates the operating voltages required by the SCM circuitry

2 CONTROLS, INDICATORS, AND INPUTS/OUTPUTS

Figure 1 shows the SCM controls, indicators, and all input and output external connections.

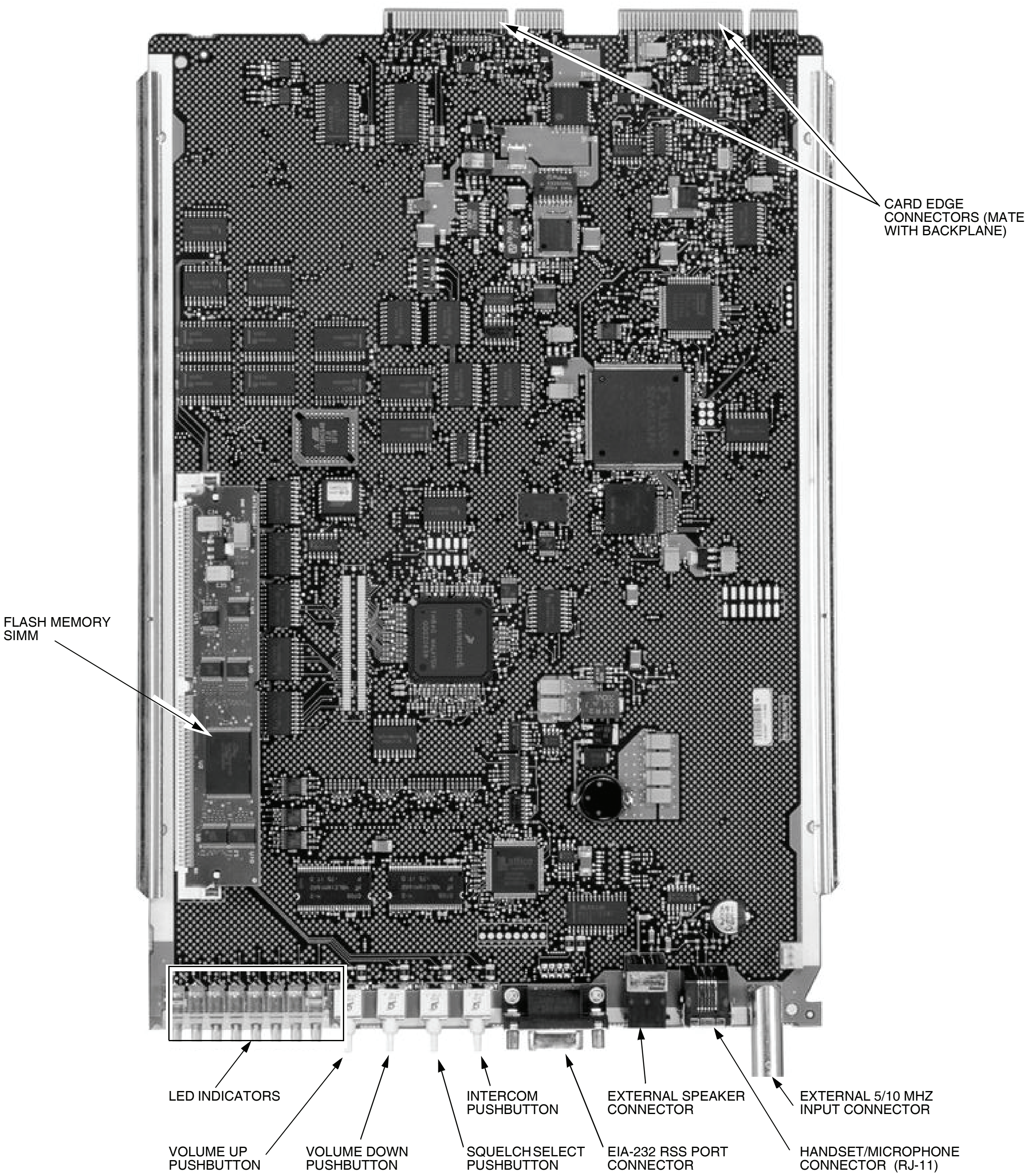


Figure 1 Station Control Module Controls, Indicators, and Inputs/Outputs

3 FUNCTIONAL THEORY OF OPERATION

The following theory of operation describes the operation of the SCM circuitry at a functional level. The information is presented to give the service technician a basic understanding of the functions performed by the module in order to facilitate maintenance and troubleshooting to the module level. Refer to Figure 2 for a block diagram of the SCM.

Host Microprocessor

Overview

The host µP serves as the main controller for the SCM (and station). The host µP, an MC68EN360 running at a clock speed of 25 MHz, controls the operation of the station as determined by the station software (contained in a FLASH SIMM module) and the station codeplug (EEPROM).

Communications Buses

The host µP provides six general-purpose serial communications buses, as follows:

- **SCC1** — Used as Ethernet port for high-speed communications, either to connect to the Ethernet local network of an IntelliRepeater trunking site or to allow station software to be downloaded from a local PC into the FLASH memory
- **SCC2** — Used as communications port to allow the station to connect into the local network of an IntelliRepeater trunking site; external connections are provided by a 9-pin D-type connector (#19) located on backplane
- **SCC3** — Used as the interprocessor communications bus (HDLC protocol) to allow the host µP to communicate with the WIB and other optional modules
- **SCC4** — Used as RS-232 port for connections to external equipment, such as a modem
- **SMC1** — Used as RS-232 port for RSS communications (9-pin D-type connector #20 on backplane)
- **SMC2** — Used as RS-232 port for RSS communications (9-pin D-type connector located on SCM front panel)

Address and Data Buses

The µP is equipped with a 28-line address bus used to access the non-volatile memory, SDRAM memory, and provide control (via memory mapping) for other circuitry in the SCM. A 32-line data bus (buffered for the non-volatile memory) is used to transfer data to/from the SCM memory, as well as other SCM circuitry.

SPI Bus

The host µP also controls the SPI bus, a general-purpose communications bus that allows the host µP to communicate with other modules in the station.

SDRAM Controller

The host µP and CPLD provides signals necessary to access and refresh the SDRAM memory.

25 MHz Clock Circuitry

A crystal-controlled 25 MHz clock circuit and buffer provide the 25 MHz clock signal to the host µP.

Non-Volatile Memory

Station Software FLASH Memory

The station software resides in a FLASH SIMM module. The FLASH SIMM is accessed by the host µP via the 28-line host buffered address bus and the 32-line host buffered data bus.

Codeplug EEPROM

The data which determines the station personality resides in an 8K x 8 codeplug EEPROM (U1700). Stations are shipped from the factory with generic default data programmed into the codeplug EEPROM. Field programming is performed during installation using the Radio Service Software (RSS) program to enter additional customer-specific data, such as site output power, time-out timer settings, etc.

SDRAM Memory

Each SCM contains 2Mx32 of SDRAM into which the station software is downloaded and run. The SDRAM also provides short-term storage for data generated/required during normal operation. Read and write operations are performed using the host buffered address and host buffered data buses.

The SDRAM memory locations are sequentially refreshed by the column and row signals from the host µP and auxiliary CPLD.

External Line Interface Circuitry

IntelliRepeater DLAN Network Port

A DLAN port is provided on the station backplane to allow the station to connect into the local network of an IntelliRepeater trunking site. This DLAN port is provided by host µP serial communication bus SCC2.

SCC2 communicates with an RS-485 bus transceiver, which provides DLAN+ and DLAN– signals. These signals are connected to a 9-pin D-type connector (#19) located on the station backplane, which typically mates with a PhoneNET adapter module connected into the IntelliRepeater local network.

Ethernet Port

An Ethernet port is provided via a BNC connector on the station backplane which allows the station to connect into the Ethernet local network of an IntelliRepeater trunking site. The Ethernet port may also be used to allow station software to be downloaded from a local PC into the FLASH SIMM module. This Ethernet port is provided by host µP serial communication bus SCC1.

General Purpose RS232 Serial Port

A general purpose RS-232 communications port is provided by host µP serial communication bus SCC4. This port is available at a DB-25 connector (#15) located on the station backplane, and may be used to connect external equipment such as an external modem.

RSS Port (Backplane)

A 9-pin D-type connector (#20) is provided on the station backplane to allow service personnel to connect a PC loaded with the Radio Service Software (RSS) and perform programming and maintenance tasks. The RSS port may also be used to allow station software to be downloaded from a local PC into the FLASH SIMM module. This RSS port is provided by host µP serial communication bus SMC1 which communicates with the RSS terminal via EIA-232 Bus Receivers/ Drivers.

RSS Port (Front Panel)

A 9-pin D-type connector is provided on the SCM front panel to allow service personnel to connect a PC loaded with the Radio Service Software (RSS) and perform programming and maintenance tasks. The RSS port may also be used to allow station software to be downloaded from a local PC into the FLASH SIMM module. This RSS port is provided by host µP serial communication bus SMC2 which communicates with the RSS terminal via EIA-232 Bus Receivers/ Drivers.

Digital Signal Processor (DSP) and DSP FPGA Circuitry

General

All station transmit and receive audio/data is processed by the DSP and related circuitry. This circuitry includes the DSP IC, the DSP FPGA, and the DSP FPGA interface circuitry. All audio signals in and out of the DSP are in digitized format.

Inputs to the DSP circuitry are:

- Digitized receive signals from the receiver module
- Audio from handset or microphone connected to appropriate SCM front panel connector; signal is digitized by the CODEC IC (audio interface circuitry) before being sent to the DSP via the audio interface bus
- Digitized voice audio/data from WIB and other optional modules via TDM bus
- ASTRO modem data from WIB via HDLC bus
- 6809/MRTI transmit audio

Outputs from the DSP circuitry are:

- Digitized voice audio/data from DSP to WIB and other optional modules via TDM bus
- Digitized voice audio from DSP to external speaker, built-in speaker, or handset earpiece via audio interface bus and audio interface circuitry
- Digitized voice audio/data from DSP to exciter module (modulation signals) via audio interface bus and audio interface circuitry
- 6809/MRTI transmit audio

Digital Signal Processor (DSP)

The DSP, a 56311 operating at an internal clock speed of 100 MHz, accepts and transmits digitized audio to/from the various modules in the station. The DSP provides address and data buses to receive/transmit digitized audio (via the DSP FPGA) and to access the DSP program and signal processing algorithms contained in DSP memory.

DSP FPGA

The DSP FPGA operates under control of the DSP to provide a number of functions, as follows:

- Interfaces with the DSP via the DSP address and data buses
- Accepts 16.8 MHz signal from Station Reference Circuitry and outputs a 2.1 MHz reference signal used throughout the station
- Provides interfaces for the HDLC bus, TDM bus, and serial bus used to communicate with the Receiver Module
- Accepts digitized data from Receiver Module via DSP FPGA Interface Circuitry
- Provides interfaces for several A/D and D/A converters

Station Reference Circuitry

Note: *Two BNC connectors (one 50 Ω input located on SCM front panel, one high impedance input located on the station backplane) are provided to allow an external 5/10 MHz source to be connected to the* OSC_{in} *input to the PLL to perform frequency netting. Refer to the Maintenance section in this manual for recommended intervals and procedures for netting the station reference.*

The station reference circuitry consists of a phase-locked loop (PLL) comprised of a high-stability VCO and a PLL IC. The output of the VCO is a 16.8 MHz signal which is fed to the DSP FPGA. The FPGA divides the signal by 8 and outputs a 2.1 MHz signal which is separated and buffered by a splitter and output to the Exciter Module and Receiver Module as 2.1 MHz REF.

The Station Reference Circuitry may operate in one of three modes:

- **Normal Mode** — In this mode, the control voltage is turned off (via control voltage enable switch) and the high-stability VCO operates in an open loop mode; stability of the VCO in this mode is 1 PPM per year after the first 6 months.
- **Manual Netting Mode** — Periodically, an external 5/10 MHz source is required to fine tune, or “net”, the 16.8 MHz reference signal. In this mode, the PLL compares the 5/10 MHz reference and a sample of the 16.8 MHz VCO output and generates up/down pulses. The host μP reads the pulses (via SPI bus) and sends correction signals (via SPI bus) to the VCO to adjust the output frequency to 16.8 Mhz ±0.3 ppm.
- **High-Stability Mode** — For some systems, such as simulcast systems, the free-running stability of the VCO is unacceptable for optimum system performance. Therefore, an external 5/10 MHz source is connected permanently to one of the BNC connectors. In this mode, the PLL compares the 5/10 MHz reference and a sample of the 16.8 MHz VCO output and generates a dc correction voltage. The control voltage enable switch is closed, allowing the control voltage from the PLL to adjust the high-stability VCO frequency to 16.8 MHz ± the stability of the external 5/10 MHz source. The VCO operates in this closed loop mode and is continually being frequency controlled by the control voltage from the PLL.

HDLC Bus Control Circuitry

The HDLC bus control circuitry provides three-state buffering and data routing for the interprocessor communications bus (a serial data bus implementing HDLC protocol). This bus allows the host μP to communicate with the host μP located on the WIB and other optional modules via an interprocessor communications bus.

Audio Interface Circuitry

General

The audio interface circuitry interfaces external analog audio inputs and outputs with the DSP circuitry. This includes the analog, integrated circuit EPSILON, and discrete amplifier and switch circuitry.

External Audio Sources

A multiplexer, under control of the host µP, is used to select one of eight possible external audio input sources (four for diagnostic loopback signals, two for future use, one for 6809/MRTI transmit audio, and one for handset or microphone audio). The selected audio source signal is converted to a digital signal by the A/D portion of the CODEC IC and sent to the DSP FPGA via the audio interface bus. The DSP circuitry processes the signal and routes it to the desired destination.

External Audio Destinations

Digitized audio from the DSP circuitry is applied to the D/A portion of the CODEC EPSILON and is then sent to one of four external devices:

- External Speaker — connects to jack located on SCM front panel
- Handset Earpiece/Microphone — connects to RJ-11 jack ( ) located on SCM front panel
- Local Built-In Speaker — internal speaker and ½ W audio amplifier; may be switched on/off and volume controlled by using volume up ( ) and down ( ) buttons on SCM front panel
- J14 on Station Backplane — 6809/MRTI receive audio output to external MRTI Module

Exciter Modulation Signals

Digitized audio/data intended to be transmitted from the station is sent from the DSP circuitry to a D/A converter via the TX/Voice Audio signal (part of the serial synchronous interface bus, connected between the DSP and the DSP FPGA). The digitized signal is converted to analog, level shifted and amplified, and fed to a 0-6 kHz filter. The output of the filter is then fed to one of the inputs of a multiplexer. The output of the multiplexer is fed to two individual digitally controlled potentiometers (each of which is adjusted by the host µP via the SPI Bus) and applied to the exciter module as modulation signals VCO MOD AUDIO and REF MOD AUDIO.

Input/Output Ports

Input Ports

Two general-purpose 32-line input ports are provided to allow various input signals from the SCM and station circuitry to be accepted and sent to the host µP. The two ports (I/O Port P0 In and I/O Port P1 In) are each comprised of 32 lines which come from circuitry in the SCM as well as other modules in the station via the backplane. The buses are received by buffers which make the data available to the host µP via the host buffered data bus. Typical inputs include the pushbutton switches located on the SCM front panel and the MIC PTT signal from the handset/microphone.

Output Ports

Two general-purpose 32-line output ports are provided to allow various control signals from the host µP to be output to the SCM and station circuitry via the backplane. The two ports (I/O Port P0 Out and I/O Port P1 Out) are each comprised of 32 lines which come from the host buffered data bus via latches. Typical output control signals include the control lines for the eight LEDs located on the SCM front panel and the local speaker enable signal.

6809/MRTI Interface Circuitry

6809 Trunking Interface

TX DATA from the 6809 trunking controller is received by the station via J14 on the station backplane. The signal is routed through nominal filtering on the 6809/MRTI interface circuitry and fed to the audio interface circuitry. The T DATA signal is then waveshaped/filtered and fed to an A/D converter in the EPSILON IC, which outputs a digital signal to the DSP via the audio interface bus.

6809 RX AUDIO is output from the DSP to the local audio circuitry via the audio interface bus. The signal is amplified, filtered, buffered in the EPSILON IC, and output through nominal filtering on the 6809/MRTI interface circuitry to the 6809 trunking controller via J14 on the station backplane.

MRTI Interface

MRTI AUDIO from an external MRTI module is received by the station via J14 on the station backplane. The signal is routed through the 6809/MRTI interface circuitry and fed to one input of an 8-to-1 multiplexer. If selected, the MRTI TX AUDIO signal is converted to a digital signal by the A/D portion of the EPSILON IC CODEC and sent to the DSP FPGA via the audio interface bus.

MRTI RX AUDIO is output from the DSP to the local audio circuitry via the audio interface bus. The signal is amplified, filtered, buffered in the EPSILON IC, and output through the 6809/MRTI interface circuitry to the external MRTI module via J14 on the station backplane.

Front Panel LEDs and Switches

Note: Refer to the Troubleshooting section of this manual for complete details on the interpretation of the LEDs.

LEDs

Eight status LEDs on the SCM front panel provide visual indications of various station operating conditions.The LEDs are controlled by eight lines from I/O Port P0 Out.

Note: Refer to the Operation section of this manual for complete details on the use of the pushbutton switches.

Switches

Four momentary contact pushbutton switches are provided on the SCM front panel to allow various station functions to be selected. Pressing a pushbutton causes a high to be sent to the host µP via I/O Port P0 In.

Supply Voltages Circuitry

The SCM contains on-board regulator and filtering circuitry to generate the various operating voltages required by the SCM circuitry. +14.2 V (A+) and +5V Vcc from the backplane are used as sources for the following supply voltage circuits:

- **VCCA Supply Circuitry** — is a +5V regulated supply derived from +14.2 V. It supplies the station reference, EPSILON, 5V-3V translators circuitry.
- **Filtering Circuitry** — filters the +14.2 V and +5V from the backplane to provide A+ and VCC, respectively, for the SCM digital circuitry.
- 3.3 V Converter Circuitry — Derived from Vcc to supply power to the DSP, FPGA, SDRAM and aux CPLD.
- Vcc Circuitry — 5 V from the backplane supplies power to the 68360 host processor, flash SIMM and interface circuitry, and digital portions of the EPSILON IC.
- 2.5V regulator circuit — derived from Vcc and supplies the core voltage of the DSP-FPGA
- 1.8V regulator circuit — derived from Vcc and supplies the core voltage of the DSP.

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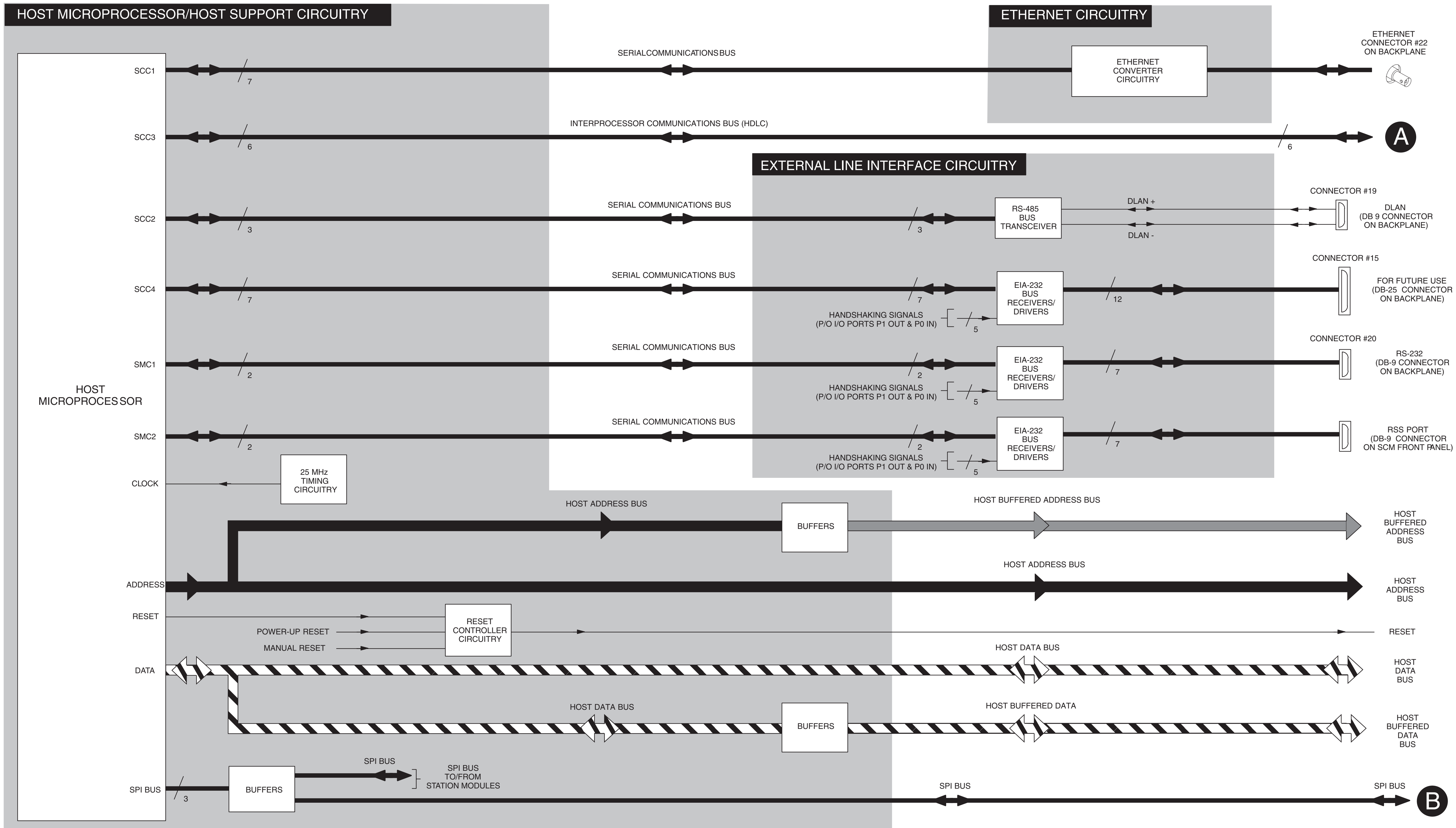


Figure 2 CLN8426A, CLN8447A Station Control Module Functional Block Diagram (1 of 5)

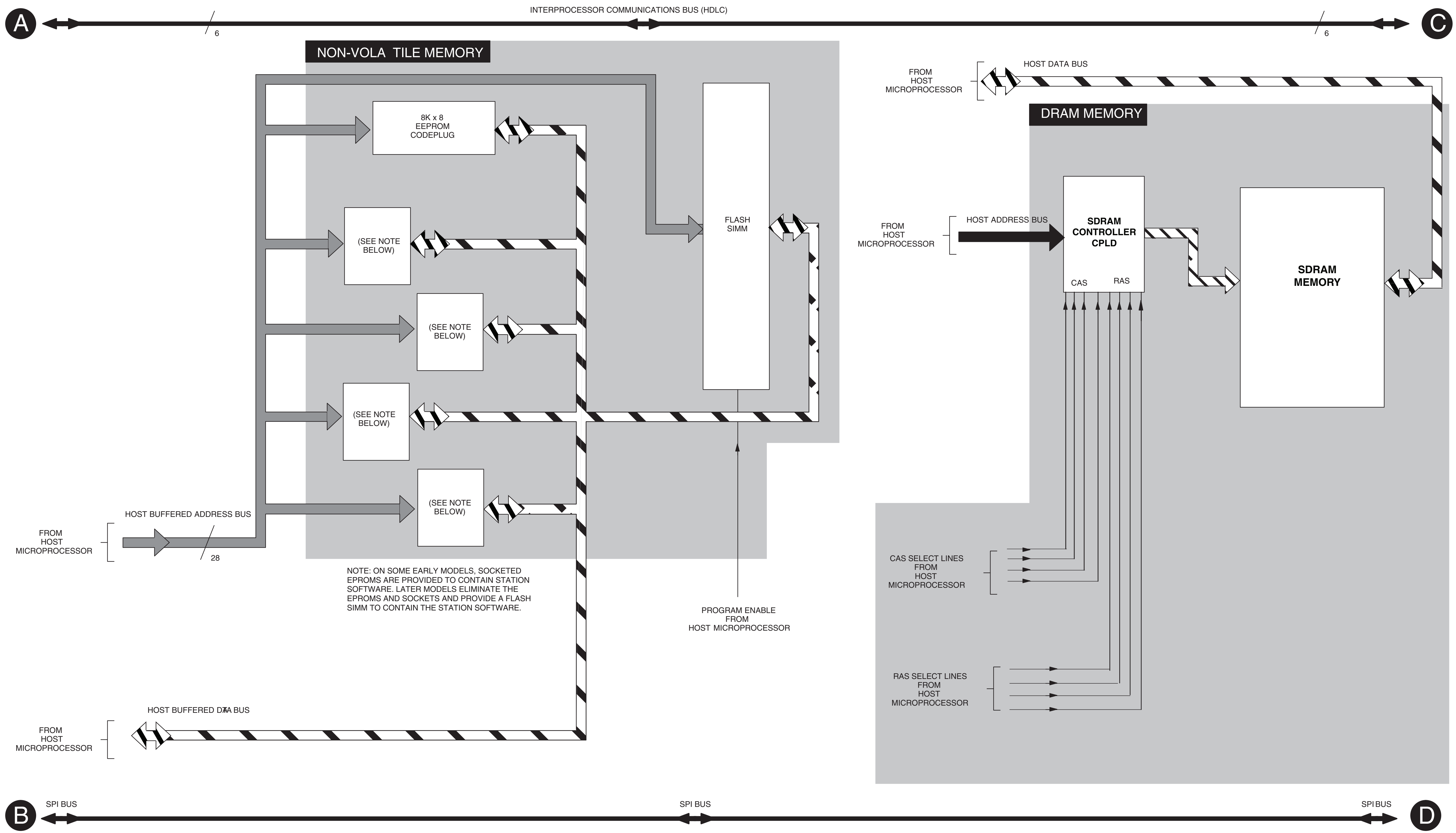


Figure 2 CLN8426A, CLN8447A Station Control Module Functional Block Diagram (2 of 5)

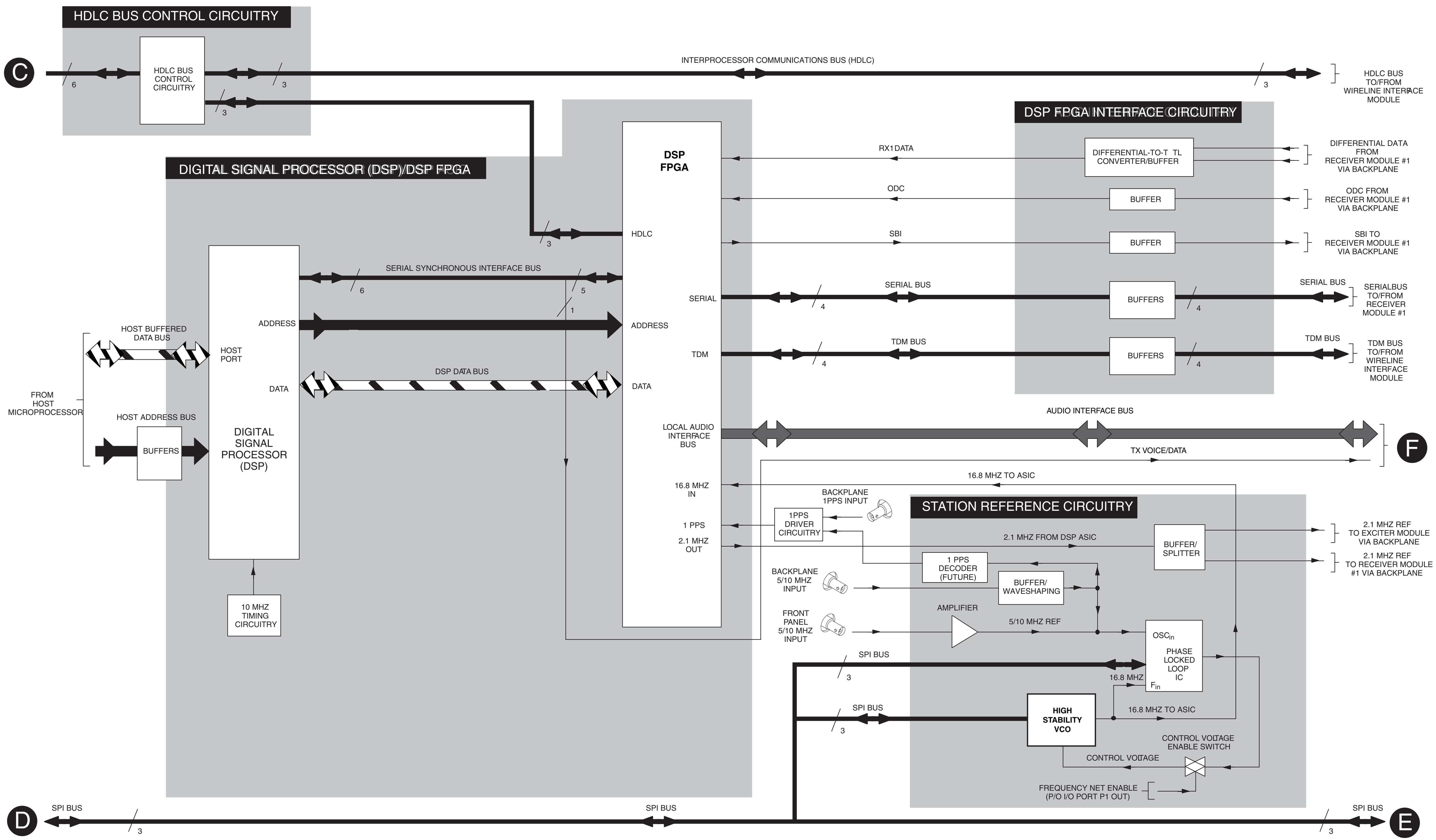


Figure 2 CLN8426A, CLN8447A Station Control Module Functional Block Diagram (3 of 5)

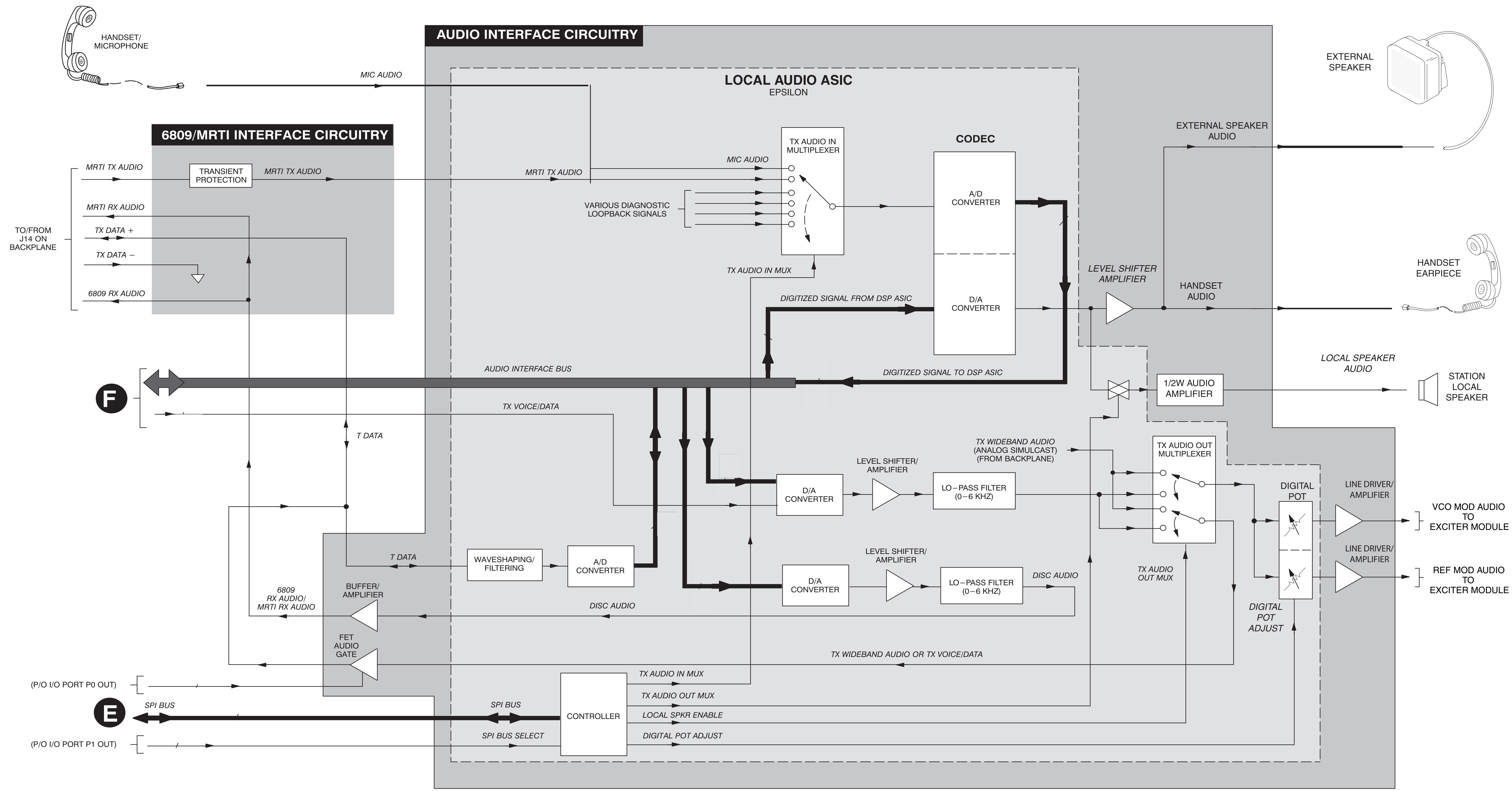


Figure 2 CLN8426A, CLN8447A Station Control Module Functional Block Diagram (4 of 5)

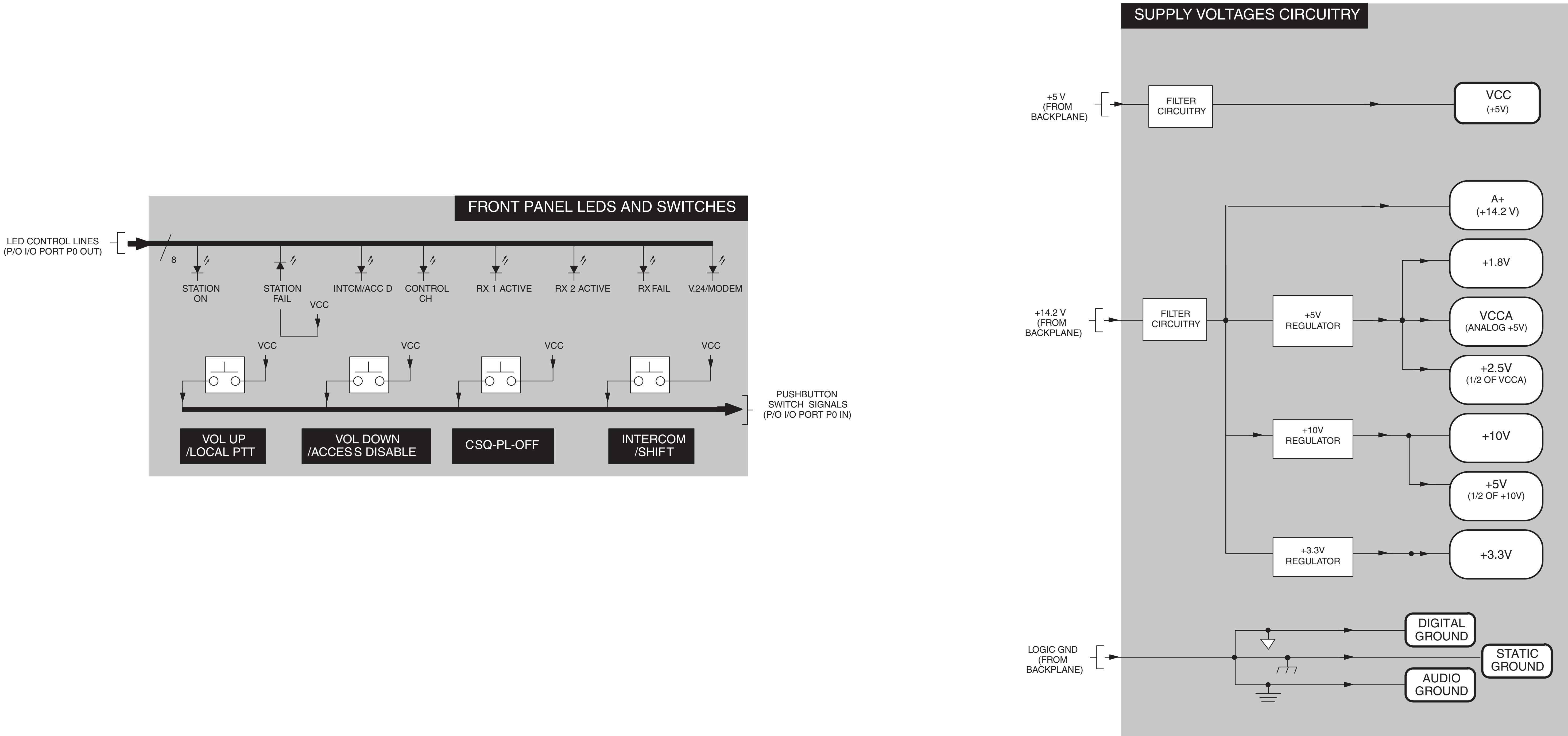


Figure 2 CLN8426A, CLN8447A Station Control Module Functional Block Diagram (5 of 5)